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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/750,248	12/31/2003	Sang Woo Nam	PIA31180/DBE/US	8857

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THE LAW OFFICES OF ANDREW D. FORTNEY, PH.D., P.C.
401 W FALLBROOK AVE STE 204
FRESNO, CA 93711-5835

EXAMINER

WEBB, GREGORY E

ART UNIT	PAPER NUMBER
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1751

SHORTENED STATUTORY PERIOD OF RESPONSE	MAIL DATE	DELIVERY MODE
3 MONTHS	01/23/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

Office Action Summary

Application No.

10/750,248

Applicant(s)

NAM, SANG WOO

Examiner

Gregory E. Webb

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 06 November 2006.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-17 is/are pending in the application.
- 4a) Of the above claim(s) 1-8 and 17 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 9-16 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- ☐ Notice of References Cited (PTO-892)
- ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- ☐ Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date _____
- ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____
- ☐ Notice of Informal Patent Application
- ☐ Other: _____

DETAILED ACTION

Response to Arguments

1. Applicant's arguments, with respect to Jolley, Bran, Clark, Liu, Berry and Yoneda have been fully considered and are persuasive. Previous 102 rejections relevant to these references are withdrawn.
2. Concerning Ramachandran, the examiner is not convinced by the applicant's arguments. These rejections are maintained.
3. The applicant argues that the Ramachandran reference teaches weight percentages whereas the instant claims are directed to volume percentages. The applicant provides no evidence or support for this argument. Nor does the applicant attempt to demonstrate any difference.
4. In a dilute aqueous system the density of the aqueous fluid will be near to 1 g/ml. For pure water the volume percent and the weight percent would be exactly equal.
5. In the instant solution the density would be slightly greater than 1.0 g/ml. A rough estimate can be calculated using a weighted average density as follows:
6.
$$\begin{aligned} \text{density} &= 8.5\% * 1.8 \text{ (density H}_2\text{SO}_4\text{)} + 19\% * 1.44 \text{ (density H}_2\text{O}_2\text{)} + 70.5\% * 1.0 \\ &= 0.153 + 0.2736 + 0.705 = 1.13 \text{ g/ml} \end{aligned}$$
7. Using this average density one can convert volume percents to weight percents as follows:
8.
$$\text{weight percent} = \text{volume percent} * \text{density of material} / \text{density of fluid}$$
9. Thus for the applicant's approximate ranges the following calculations can be made:

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10. $70.5-80.5$ volume percent water = $70.5 \times 1.0 / 1.13 = 62.4 - 71.2$ weight percent
11. $6.5-8.5$ volume percent H_2SO_4 = $6.5 \times 1.8 / 1.13 = 10.35 - 13.5$ weight percent
12. $15-19$ volume percent H_2O_2 = $15 \times 1.44 / 1.13 = 19.1 - 24.2$ weight percent
13. Noting that the weight percents would be slightly less owing to the small amount of HF added to the solution.
14. Thus we can see that the applicant's claimed range of components clearly overlaps those of the prior art. As the prior art teaches each and every material limitation as well as those process limitations such claims are anticipated by the Ramachandran reference.

Claim Rejections - 35 USC § 102

15. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.
16. Claims 9-16 remain rejected under 35 U.S.C. 102(b) as being anticipated by Ramachandran (US6630074).

Concerning the DIW, H.sub.2SO.sub.4, H.sub.2O.sub.2 and the HF, Ramachandran teaches the following:

The etchant compositions of the present invention are aqueous solutions containing about 0.01 to about 15 percent by weight and preferably about 1 to about 10 percent by weight of **sulfuric acid** and about 0.01 to about 20 percent by weight of **hydrogen peroxide**, 0.1 to about 100 ppm of **hydrofluoric acid** and preferably about 1 to about 10 percent by weight of **hydrogen peroxide** or about 1 to about 30 ppm and preferably about 5 to about 20 ppm of ozone with the balance being substantially water, and more preferably contain about 0.1 to about 100 ppm of a fluoride containing compound, preferably **hydrofluoric acid**. It is not necessary that the fluoride containing compound be **hydrofluoric acid**. It is

necessary that the fluoride containing compound contribute free fluoride to the etchant composition. It is preferred that the fluoride containing compound be able to contribute the equivalent of at least about 8 and at most about 12 ppm of **hydrofluoric acid** to the etchant solution. A preferred composition of the present invention is an aqueous solution of about 8 percent by weight of **sulfuric acid**, and about 1.5 percent by weight of **hydrogen peroxide** and the remainder being substantially water, and more preferably contain about 10 ppm of a fluoride containing compound, preferably **hydrofluoric acid**. This composition is preferably employed at temperatures of about 35.degree. C. Another more preferred composition of the present invention is an aqueous solution of about 9 percent by weight **sulfuric acid** and about 4 percent by weight **hydrogen peroxide** and the remainder being substantially water, and more preferably contain about 10 ppm of a fluoride containing compound, preferably **hydrofluoric acid**. This composition is preferably employed at temperatures of about 35.degree. C. and is especially preferred for removing thicker and more tenacious sidewall polymer. Yet another more preferred composition of the present invention is an aqueous solution of about 5% by weight of **sulfuric acid**, about 12% by weight of **hydrogen peroxide** and about 10 ppm **hydrogen fluoride**. The water employed is preferably **deionized water**. (*emphasis added*)

Concerning the method for removing polymer, Ramachandran teaches the following:

An aqueous etchant composition containing about 0.01 to about 15 percent by weight of sulfuric acid and about 0.01 to about 20 percent by weight of hydrogen peroxide or about 1 to 30 ppm of ozone, and about 0.01 to 100 ppm of hydrofluoric acid is effective in **removing polymer** and via residue from a substrate or conductive material, and especially from an integrated circuit chip having aluminum lines thereon.

(*emphasis added*)

Concerning the post-etching process, Ramachandran teaches the following:

The etchant compositions of the present invention remove the sidewall polymer residue remaining after the reactive ion **etching** and with it removes any embedded chlorine. The etchant compositions of the present invention also clean vias of other residues, including, but not limited to, oxygen, carbon, silicon and elements of an underlying conductive material. Furthermore, the etchant compositions of the present invention, at most, only mildly etch the aluminum/copper line. Since hydrofluoric acid is known to etch aluminum/copper, the amounts in the etchant solution must be small. When the amounts of hydrofluoric acid in the claimed

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etchant solution are kept small (less than about 40 ppm) the potentially detrimental effects of the hydrofluoric acid on aluminum/copper are minimized. In most cases, no evidence of any local **etching** of the aluminum; even aluminum in the vicinity of tungsten studs, has been observed. The tungsten seems to act as a catalyst in **etching** aluminum when using the prior art chromic/phosphoric acid bath. They also can be used to remove and clean residues after chemical-mechanical polishing and other 'cleaning' processing steps. (*emphasis added*)

Concerning the protective oxide film, Ramachandran teaches the following:

Additionally, after a RIE process, sidewall polymers remain on the semiconductor wafer surface. These sidewall polymers, known as "polymer rails" are inorganic in nature and have various chemical constituents, including aluminum, silicon, titanium, oxygen, carbon and chlorine. Since each of these constituents tend to react and/or interfere with the semiconductor wafer function, removal of the sidewall polymers is therefore desirable. A post metal RIE cleaning step is presently done using a chromic/phosphoric acid etch, or solvent based chemistry methods. However, one common chemical constituent with a solvent based chemistry is an amine which can cause problems with certain types of photoresists. Solutions which are based on diluted sulfuric acid and hydrogen peroxide mixtures have been introduced in an attempt to remove polymer rails. However, these methods have not been successful in removing all types of polymer rails. For example, as shown in FIG. 1, in regions where there is an isolated metal pad which has a metal line density lower than the array region of the semiconductor chip and a surrounding region which is predominantly silicon oxide, current methods are less than completely successful. FIG. 1 illustrates a situation where the use solution of the present invention would be indicated. In FIG. 1, a wafer is shown after it has undergone a RIE process. The direction of the RIE process is shown by the arrow. The structure shown, 10, can be comprised of multiple layers. For example, there can be an **oxide layer**, 11, and a conductive layer, 12. The RIE process selectively removed portions of the conductive layer to expose the **oxide layer**. Accordingly, there is little to no residual left on the surface, 5, of the oxide, 11. The RIE process was, in this case, directed at the surface, 5, as shown by the arrow. However, the structure, 10, may contain a solid film, 15, covering the sidewalls, 13 and the top, 14, of the structure, 10. (*emphasis added*)

Conclusion

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17. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Gregory E. Webb whose telephone number is 571-272-1325. The examiner can normally be reached on 9:00-17:30 (m-f).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Douglass McGinty can be reached on (571)272-1029. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

A handwritten signature in black ink, appearing to be 'G Webb', with a stylized, cursive script.

Gregory E. Webb
Primary Examiner
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gew